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(54) Method and system for increasing quality of service at or below a threshold cost

(57) A method and system for managing the routing of communications data, such as real-time multimedia exchanges between remote sites, includes monitoring various communications modes, with each mode having pre-established quality of service parameter values and a pre-established session tariff. Some of the modes provide variable quality of service. The variable modes are monitored continuously to determine present-time quality of service parameter values. When a request to establish a communication session is received, the request will specify quality of service requirements. An acceptable session tariff is calculated based upon the match of the specified requirements with the pre-established parameter values of the modes. In a preferred embodiment, the next step is to select that mode having the highest quality of service available for a session tariff that does not exceed the predefined acceptable session tariff. In this embodiment, the tariff of the selected mode may be greater than an alternative mode that satisfies the QoS requirements, but only if the selected mode has a greater QoS. In another embodiment, real-time multimedia sessions are conducted using available modes that include the global Internet, and the session tariff becomes more of a factor. In a third embodiment, the user identifies a QoS level and an acceptable session tariff, and the system notifies the user when present-time quality of service is available at the acceptable session tariff.

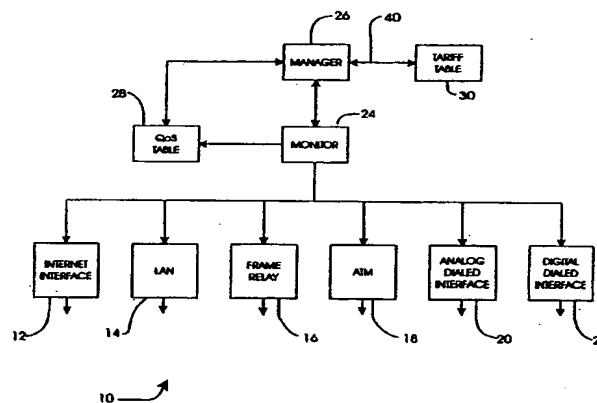


FIG. 1

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Description

BACKGROUND OF THE INVENTION

The invention relates generally to methods and systems for managing communications routings between remote sites and more particularly to selecting among a number of communications modes accessible to the system.

DESCRIPTION OF THE RELATED ART

There are an increasing number of communications modes for conducting communications sessions, such as real-time multimedia connections. The differences in the modes may be medium-based, protocol-based and/or service-based, for example. A medium-based mode difference relates to the physical layer of communications between remote sites. A common physical medium for communications from a site within a local area network (LAN) to a site outside of the network is an analog line leased from a telecommunications provider. Another physical medium is a fiberoptic line, such as the digital data transmission lines of a synchronous optical network (SONET).

A protocol-based difference in communications modes is at a higher layer than medium-based differences. Within the global Internet, Transmission Control Protocol (TCP) is relied upon at a transport layer, and Internet Protocol (IP) is relied upon at a network layer. However, alternative protocols are available and are used within other digital communications modes and in analog communications modes.

Differences within communications modes may be related to whether network interfaces are packet-switched or circuit-switched. Synchronous Transfer Mode (STM) technology provides a circuit-switched network mechanism in which a connection is established and maintained between two remote sites to initiate the communications session, and the connection is torn down following the session. On the other hand, Asynchronous Transfer Mode (ATM) is a high bandwidth cell-switching technology that is used to provide fixed-size cells for transmitting voice, video, data and other information. The protocol for ATM may be IP and the physical layer may be a SONET link. Another important technology related to this type of mode differentiation is the Frame Relay, which provides fast packet multiplexing and is designed to accommodate efficient wide area networks (WANs).

Within the ATM environment, various service-based communications modes may be implemented. For example, basic-rate Integrated Services Digital Network (ISDN) provides use of two B-channels and a single D-channel to residences and businesses that are provided with a basic-rate interface. A higher bandwidth ISDN service is provided by a primary-rate ISDN interface that consists of twenty to thirty B-channels for user data and

a single D-channel for signaling. Broadband ISDN provides even higher transmission speeds. Broadband ISDN is supported by transmission technologies other than ATM. Moreover, the non-ATM technologies support services that are not available in the ATM environment.

A sub-category of the service-based communications modes relates directly to throughput, i.e., the effective network transmission speed, or bandwidth. A committed bit rate (CBR) service provides a set throughput with a low and stable delay. On the other hand, available bit rate (ABR) service provides users with a bandwidth suitable for supporting a particular communications session. The network will provide connectivity for the session based upon the requested parameter values. Typically, the throughput for an ABR service varies with the traffic at the time of the session. However, there is an "advertised" bandwidth that provides a guaranteed throughput for a session. For example, in an ATM network, the transmissions may be guaranteed to travel at 10 Mbit/second, with bursts of 45 Mbit/second for times in which the use of network resources is low.

In addition to having an "advertised" bandwidth, most communications modes have advertised parameter values for other factors related to quality of service (QoS). An important quality of service parameter is cell or packet loss. Within an ATM environment, data is transmitted in cells having a length of 53 bytes, with 5 bytes being used as a header and the remaining 48 bytes comprising the payload. Cell loss will adversely affect the quality of service. Another parameter of concern is time delay, sometimes referred to as "latency." Still referring to the ATM environment, latency is a measure of time required for a cell to reach a receiving station. A related parameter is "jitter," which is the variation in latency for different cells.

Real-time multimedia communications over networks, such as the global Internet, have become more cost effective than multimedia communications over the public switching telephone network (PSTN). However, the quality of the communications, such as voice quality and video quality, depends upon the selection of communications modes and upon traffic along the network, if the mode is an ABR service. Static routing of single-medium and multimedia communications over an integrated network is well known. For static routing, the user specifies the quality of service requirements and the integrated network negotiates connectivity based upon conditions at the time that the request is received. During the session, the traffic may change significantly and the quality of service may drop below the requested level. The users may continue with the low quality communication or may disconnect and then re-establish the communication. Since the initial negotiation is typically to find the communications mode having the lowest tariff with the required level of QoS, the re-established communication is likely to be fixed at a higher tariff.

Within some networks, renegotiation of quality of

service may be implemented during a session. If video information is to be transmitted during a session that was originally connected for voice-only, advanced networks may allow the user to initiate a renegotiation that establishes a second connection before the original connection is torn down. The second connection utilizes communications modes suitable for the increased QoS requirements.

A more complex in-session renegotiation is described in U.S. Pat. No. 5,446,730 to Lee et al. The method described in Lee et al. provides dynamic connection management in an integrated communications network. Re-optimization may take place for cost improvement. As previously noted, the tariff (i.e., cost) of connectivity depends upon the selected communication modes, and the tariffs are typically inversely proportional to the guaranteed quality of service. The patent to Lee et al. states that because of changes in the network or changes in the supporting connections, the cost of a given connection may not be minimal for the entire session. After a link fails, connections are re-established over paths with potentially higher costs. The re-optimization of Lee et al. prevents the connections from being fixed within the unnecessarily costly paths. The re-optimization may be triggered by a network administrator, by passage of a set period of time, or by the time of day. For re-optimization, all agreed performance values and effective resource constraints must not be degraded, and the cost must be reduced sufficiently to justify the process. Another feature of Lee et al. is enhancement. Enhancement is utilized to guarantee that negotiated performance values extend over the duration of the session. The network monitors changes in the network and provides renegotiation when the quality of service degrades. The renegotiation does not consider the cost of the connection.

Monitoring a network is also described in U.S. Pat. No. 5,408,465 to Gusella et al. The results of the monitoring are employed at the original setup level of a session, rather than for renegotiation. The monitoring is used as a basis for predicting the quality of service for the duration of a session. Predicted values are utilized while attempting to find a path that satisfies the requirements of a particular communication.

The prior techniques for predicting quality of service for the duration of a session requesting establishment and the prior techniques for re-establishing connections in response to detection of degraded quality of service or reduced tariff provide significant advantages to network users. The common theme is to provide a minimal cost for a session by minimally satisfying quality of service requirements.

What is needed is a method and system that maximize the quality of service at a tariff that is acceptable to users.

SUMMARY OF THE INVENTION

A method and system for managing the routing of communication data between remotely located sites includes monitoring various communications modes, with each mode having pre-established quality of service parameter values and a pre-established session tariff. By monitoring at least those modes that have variable quality of service, the present-time quality of service parameter values are known. Upon receiving a request to establish a communication session having specified quality of service requirements, the pre-established parameter values may be used as a basis for calculating a session tariff that is acceptable to the users. The present-time quality of service parameter values may then be used to select modes that provide the highest present-time quality of service at or below the calculated acceptable session tariff. In this embodiment, the monitoring is for the purpose of maximizing the quality of service that is available at a calculated maximum tariff. However, connectivity resources of a second mode having pre-established parameter values which satisfy the request preferably are reserved in order to accommodate the session if the present-time quality of service of a selected mode degrades. That is, resources are reserved to allow fallback connectivity on an "as-needed" basis.

In the preferred embodiment, the monitoring of the communications modes is continuous and in-session switching between modes is executable. The in-session switching occurs in response to detecting a condition in which an alternative mode provides a higher present-time quality of service at a session tariff no greater than the calculated acceptable session tariff. Alternatively, if the quality of service of the originally selected mode degrades to a level below the quality of service requirements of the session, an alternative mode that satisfies the requirements at an acceptable session tariff is substituted. Preferably, if the switching takes place between two modes that both have present-time quality of service parameter values satisfying the requirements, the method includes a step of weighting the pre-established session tariffs to prevent reconnection costs from increasing the total session tariff to a level above the acceptable session tariff.

In another embodiment, the communications sessions are real-time transmissions of multimedia data and in-session switching among modes is executed to achieve cost-efficiency while providing a present-time quality of service satisfying the requested requirements of the multimedia session. In this embodiment, at least some of the modes are distinguishable with respect to protocol and one of the available protocols is the Internet Protocol. Other modes may be distinguishable with respect to transmission media, including analog lines and digital lines.

A third embodiment may be used for communications sessions that are not schedule-critical, i.e., situa-

tions in which a user is willing to wait for the start of a session in order to take advantage of low traffic circumstances. In this embodiment, each communications mode has a pre-established session tariff and each mode is monitored to determine the present-time quality of service of the mode. The request by a user to establish a communications session indicates a minimum quality of service and a maximum session tariff. The indication of the maximum session tariff may be inferred from a request for a particular mode. If one of the modes satisfies the indicated minimum quality of service within the indicated maximum session tariff, the connectivity is established using that mode. On the other hand, if none of the modes satisfies the indicated minimum quality of service within the maximum tariff, the request is queued and the present-time quality of service parameter values of the various modes are tracked until a specific mode has a present-time quality of service that satisfies the indicated minimum quality of service within the indicated maximum session tariff. The user is then notified of the availability of resources that provide the quality of service at the desired tariff.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a system for managing real-time communications sessions, with the system including interfaces compatible with different communications modes in accordance with the invention.

Fig. 2 is a block diagram of the manager device of Fig. 1 with connections to the input and output devices.

Fig. 3 is a flow chart of steps for selecting among the communications modes accessible via the system of Fig. 1, in accordance with one embodiment of the invention.

Fig. 4 is a table of values formed using the process of Fig. 2.

Fig. 5 is a flow chart of steps for selecting among the communications modes of Fig. 1 in accordance with an alternative embodiment of the invention.

DETAILED DESCRIPTION

With reference to Fig. 1, an integrated network 10 has the capacity to select among various communications modes for conducting communications sessions between remote sites, not shown. In the preferred embodiment, the network is a system for real-time multimedia communications, such as video and voice data of a telecommunications conference. The components of Fig. 1 are network components that determine the quality of service (QoS) of the sessions.

The difference between communications modes may be any one or all of medium-based, protocol-based and service-based differences. Moreover, the mode difference between two alternatives may be a difference between packet switching and circuit switching. Fig. 1 shows six alternatives. An Internet interface 12 may be

a modem for connecting one video conference site to another video conference site via an Internet Service Provider (ISP). Alternatively, the sites may be both located on the premises of a corporation, so that the sites can be connected via a corporate local area network (LAN) 14. A Frame Relay 16 and an ATM interface 18 illustrate two other possible communications modes. Alternatively, an analog dialed interface 20 and a digital dialed interface 22 are shown in Fig. 1. The analog dialed interface and the digital dialed interface may be connected to separate leased lines of a public switched telephone network (PSTN).

Each one of the communications modes has at least one "advertised" quality of service that provides guarantees for a session. For some modes, there may be more than one advertised quality of service. For example, ATM offers at least three such levels at different session tariffs. The quality of service may also be measured in terms of packet losses, latency and/or jitter. For some of the communications modes available in Fig. 1, the quality of service parameters are relatively fixed. For example, the digital dialed connections may be associated with a fixed throughput of 128 kbps. On the other hand, quality of service of other modes may fluctuate significantly. As one example, the connection via the Internet interface 12 will fluctuate significantly depending upon traffic. While the "advertised" quality of service may be a guaranteed delay of 30 milliseconds, the actual delay may be 15 milliseconds, if the traffic along the communication lines is low.

Within many prior art techniques, a system for establishing real-time communications sessions considers only the guaranteed quality of service parameter values. This provides assurance that the quality of service will remain at a requested level throughout the entire session. Quality of service requirements may relate to various parameters, including packet loss, delay, jitter, priority and security. At the initiation of a session, the quality of service requirements are received and matched with parameter values associated with the different communications modes. The appropriate mode is selected and utilized to implement the session.

In the preferred embodiment of the invention, the integrated network 10 of Fig. 1 accesses the guaranteed quality of service values of the various alternative modes in order to determine an acceptable session tariff, but monitors the actual (i.e., present-time) quality of service for all of the other available modes. The monitoring is continuous, so that in-session mode switching is enabled. A monitor device 24 is connected to the individual network access points 12, 14, 16, 18, 20 and 22 for accessing the different communications modes. As will be explained more fully below, a mode manager 26 controls the connectivity and receives data from a QoS table 28 and a tariff table 30.

Referring now to Fig. 2, the manager device 26 includes memory 32 for the pre-established guaranteed QoS parameter values for the various communications

modes. The memory provides information to a mode select/controller device 34. The mode select operation of this device is similar to the operations of prior art devices for negotiating a connection path for communications on a session-by-session basis. The mode select/controller device includes an input 36 for identifying quality of service requirements for a particular session. In the preferred embodiment, the integrated network accommodates real-time multimedia sessions. Thus, the quality of service requirements will typically relate to a combination of voice, video, image and data parameters. The mode select/controller device 34 matches the quality of service requirements with parameter values of the available communications modes in order to select a mode that will function as a "fallback" mode for the session. Resources of the fallback mode are reserved and are then utilized on an "as-needed" basis, ensuring that resources are available throughout the session.

A second input 40 of the mode select/controller device is the information from the tariff table 30, which stores identification of the costs of utilizing the different modes available to the integrated network. Often, the tariffs are not fixed. For example, analog leased lines are typically less costly to use during off-hours, such as weekends. The tariff table preferably has sufficient information to allow an accurate identification of the present-time tariff for each of the available modes.

If more than one available mode is identified by the mode select/controller device 34 as satisfying all of the QoS requirements for a particular session, the mode select/controller device 34 determines which of the designated modes is the least expensive to implement. The tariff that is associated with this mode is then identified as the "acceptable session tariff," since the QoS requirements at input 36 necessarily carry this session tariff as a minimum. This mode is identified as the fallback mode, and the necessary communications resources are reserved, as previously noted.

The mode select/controller 34 has a third input 42 from the present-time quality of service table 28. As previously noted, the monitor device 24 of Fig. 1 is connected to each of the network access points 12, 14, 16, 18, 20 and 22. The monitor device may utilize any of known techniques for determining actual quality of service parameter values. For example, received packets containing multimedia information of other sessions may be monitored for the time of arrival. In addition, the length of a buffer queue feeding to a multimedia decoder is monitored. Of special interest is the case in which the buffer queue is empty as a result of a packet being lost or delayed through the network. Monitor device 24 collects statistical information relating to quality of service, e.g., delay, latency, jitter and data loss. Depending upon the type of communication (e.g., voice, video, image or data) and the decoding mechanism used, the impact to the quality of service from the delayed arrival or lost packets is assessed. This assess-

ment is used to update the present-time quality of service table 28.

In the preferred embodiment, the mode select/controller 34 determines whether a higher quality of service is available for individual sessions without exceeding the determined acceptable session tariff. For example, if the global Internet is providing an unusually high quality of service because of the low present-time traffic, its QoS parameter values may satisfy all of the requirements of a particular session at an equal tariff, or perhaps a lower tariff. While the originally selected mode may satisfy all of the requirements, the mode select/controller preferably switches the session to the mode that offers the higher quality. However, in the preferred embodiment, the tariff table 30 also identifies the cost of switching connectivity, so that this may be factored into the determination as to whether the mode switch is desirable. The mode select/controller is connected to all of the interface devices 44 and enables the devices on a session-by-session basis to connect various multimedia sites 46, 48 and 50 over the selected communications mode.

The steps for the preferred embodiment are shown in Fig. 3. At a start 52 of a process for initiating a communications session, such as a real-time multimedia session, the QoS requirements are established at step 54. This step may be executed by a direct input of desired quality of service by a calling party. Alternatively, the QoS requirements may be established by inferring the desired quality of service based upon the type of call (e.g., a videoconference) and/or based upon the identity of the calling party. For example, a table of "inferred QoS requirements may be stored and then accessed on a session-by-session basis. In Fig. 2, the QoS requirements are input to the mode select/controller device 34 at input line 36.

In step 56, the mode select/controller device 34 compares the QoS requirements of the session to the pre-established quality of service guarantees of the various available interface devices 44. These QoS guarantees are continuously available at step 58. The comparison of the QoS requirements and QoS guarantees typically will result in a preliminary selection of at least one available mode that satisfies all of the QoS requirements of the session.

The one or more preliminarily selected modes are used to determine an acceptable session tariff at step 60. In the embodiment of Fig. 2, the determination of the acceptable session tariff is executed at the mode select/controller 34 with an input 40 from the tariff table. This input step is shown at 62 in Fig. 3. The "acceptable session tariff" is defined as the least expensive tariff for implementing the session using a mode having QoS guarantees that satisfy all of the QoS requirements. Referring now to Fig. 4, the mode select/controller may be used to construct a table having a first column 64 that identifies the available modes for implementing the session. The second column 66 may be used to identify

the present-time session tariffs for the various modes, while the third column 68 stores the guaranteed QoS for the modes. The column values have been simplified for the purpose of explanation. All of the values represent values on scales having a lowest parameter value of 0 and highest parameter value of 10. Typically, a multimedia session will identify a number of different QoS parameters of concern. Moreover, the exemplary table does not show that some modes (e.g., ATM) may actually be multiple modes with different QoS guarantees.

Using the simplified table of Fig. 4, if the QoS requirements input at step 54 define a QoS parameter value of 6, the selected mode subset at step 56 will comprise the ATM connection, the analog dialed connection and the digital dialed connection. Then, the determination of an acceptable session tariff in step 60 will be the designation of tariff value 2, since the ATM connection in the table of Fig. 4 is the least expensive of the three connections that guarantee to satisfy the QoS requirements of the session. The ATM mode is identified as the fallback mode from which resources are reserved for use on an as-needed basis.

The steps of selecting a mode subset 56 and determining the acceptable session tariff 60 are executed at the mode select/controller 34 of Fig. 2. In another control operation, the connectivity resources of one of the modes (i.e., the fallback mode) are reserved at step 61 in order to ensure that the QoS requirements will be satisfied throughout the communications session. The mode from which the resources are reserved is that mode that has QoS guarantees satisfying the QoS requirements of the session with the least expense. In the example immediately above in which the required QoS parameter value was "6," connectivity resources for the ATM mode will be reserved, since the ATM connection provides the least expensive connection of the three modes having the required QoS guarantees. While the resources remain reserved, the resources are not necessarily utilized.

In the next step 70, one of the modes is selected for implementing the session. In practice, there may be more than one selection, since there is more than one layer in the connectivity scheme, e.g., alternative modes at the physical medium layer (wires versus optical fibers) and alternative modes at the transport layer (different protocols). However, only one selection is considered in the process flow of Fig. 3. A parallel process flow may be executed for other mode selections.

The selection of the session mode at step 70 is made using present-time QoS values input at step 72, rather than using the QoS guaranteed values of the modes. Again referring to the table of Fig. 4, the present-time QoS values at time 1 (t1) are shown in the fourth column 74. Still using the example from above, since the QoS requirements of the particular session designate a QoS value of 6, the LAN connection or the Frame Relay connection may be used at a lesser cost, but with acceptable performance. In the preferred

embodiment of the invention, the Frame Relay connection is selected, since it establishes the highest quality of service at a tariff that does not exceed the "acceptable session tariff" of the ATM connection, i.e., a session tariff of 2. While a tariff-free session is available using the LAN connection, this mode does not provide the best available present-time QoS within the tariff range.

The selection of the session mode at step 70 also considers the pattern of present-time QoS values for the modes. That is, the pattern of behavior of the present-time QoS values is analyzed to predict whether a particular mode will have a continued present-time quality of service that satisfies the requirements of a session. If the quality of service of the particular mode has been fluctuating significantly for the time period immediately preceding the request to establish a session, the mode may be determined to be inappropriate for establishing the session. The analysis of the pattern of behavior is also implemented in in-session switching, reducing the likelihood that repeated mode switching will increase the cost of the session.

In step 76 of Fig. 3, the selected session mode is used to implement the session. However, the process is contained in order to ensure that the quality of service is maintained throughout the duration of the session and to provide the highest QoS at a tariff that does not exceed the previously defined acceptable session tariff. In step 78, the monitor device 24 of Fig. 1 continues to monitor the various network access points 12, 14, 16, 18, 20 and 22. The continuous monitoring process allows the present-time QoS table 28 to be updated as changes are detected. The updates are executed at step 80 of Fig. 3. Referring again to the table of Fig. 4, the present-time QoS parameter values changed for the first four modes during the time between t1 and t2. The t2 values are found in the fifth column 82 of the table. Because the previously selected mode, i.e. the Frame Relay connection, no longer provides the required QoS, the system switches from this mode. In Fig. 3, a decision is executed at step 84 as to whether the selected mode still has the highest quality of service at the acceptable session tariff defined in step 60. If this query results in a positive response, the process returns to step 78. On the other hand, if the response is negative, such as in the situation of table 4, a step 86 of switching to an alternative mode is executed. The alternative mode must still satisfy all of the QoS requirements of the session and must be at or below the predefined acceptable session tariff. Moreover, the analysis of the pattern of behavior of the alternative mode with respect to QoS must indicate that the alternative mode is sufficiently stable over time to sustain the required QoS. This prediction is based upon the data that is stored with each update of the QoS table in step 80. In the table of Fig. 4, there are two separate and equally important reasons why the Frame Relay connection would be torn down and the ATM connection would be established. Firstly, the Frame Relay connection no longer provides

the required QoS at time t2. Secondly, the ATM connection now provides the highest QoS at the tariff that does not exceed the acceptable session tariff. Consequently, even if the Frame Relay connection still provided a QoS value of 7, the switch would be made to the ATM connection.

In the preferred embodiment, the mode switching step 86 includes some "hysteresis." For example, if the cost of switching modes is substantial and the original mode still provides the required quality of service, the switching step is inhibited. Step 88 provides the switching costs to make such a determination. Inhibiting the switching may also be a result of repeated switches.

While the preferred embodiment of the invention implements the switches based upon providing the highest quality of service at a session tariff that does not exceed a defined tariff, another embodiment does factor cost during in-session switching. In this embodiment, at least some of the available modes are distinguishable with respect to protocol and one of the available protocols is the Internet Protocol (IP). In Fig. 3, steps 54, 56, 58, 60 and 62 are preferably executed in the same manner described above. In step 70, the quality of service and the session tariffs of the available modes are considered. At time t1, the LAN connection will be selected, since the present-time QoS has a value 6 that satisfies the requirements of the session (i.e., QoS = 6), and the LAN connection is less expensive than the Frame Relay connection that was selected in the previously described embodiment. Steps 76, 78 and 80 are executed in the same manner described above, but the decision at step 84 again factors in the session tariffs of the modes.

Fig. 5 illustrates a third embodiment of the invention. In this embodiment, a request is received at step 90 to establish connectivity for a communications session, such as a multimedia session. The request includes either an implied or a specified quality of service. The implication of the quality of service may be determined based upon the identification of the type of session that is to be established. For example, a request to establish a videoconference implies a relatively high quality of service. The tariff that is specified may also be implied. Referring briefly to Fig. 4, a request for an ATM connection automatically implies that a user is willing to pay a session tariff of value "2." If the session tariff is indicated to have a value of "2" and the requested QoS has a value of "8," at time t1 none of the modes of the table will satisfy the connectivity request. Thus, the connectivity request is temporarily suspended. In Fig. 5, the determination of the availability of a suitable mode is at step 92, with tariff and QoS inputs of steps 94 and 96.

If at step 92 it is determined that one of the modes has the required present-time QoS at or below the specified tariff, the connection is established. On the other hand, if as noted above there is a situation in which none of the available modes has a present-time QoS at

the acceptable tariff, the request is looped at step 92 until an update of the QoS value shows that the required values are now available at the acceptable tariff. During that time, the caller is free to remain off-line. At time t1 in the table of Fig. 4, none of the available modes has the acceptable combination of QoS and tariff. However, at the update of time t2, the ATM connection has the present-time QoS value of "9," which is above the specified value of "8." In step 98, the party is notified that a mode having an acceptable QoS at an acceptable tariff is now available, and in step 100 the session is initiated. The notification at step 98 preferably requests a party to verify that the session is still desired, prior to initiating the session at step 100. However, such a request is not critical. In fact, notification prior to session connection is not critical.

An advantage of the embodiment of Fig. 5 is that a call that is not schedule-critical can be conducted without paying the session tariff typically associated with the quality of service requested by the caller. While the quality of service may degrade after the session is established, this concern may be reduced by monitoring the pattern of QoS behavior for the modes before the connection is made.

Claims

1. A method of managing communications routing comprising steps of:

accessing capability to exchange communication data between remotely located sites using any of a plurality of distinct communications modes having pre-established quality of service parameter values and pre-established session tariffs;

monitoring at least some of said modes to determine present-time quality of service parameter values for said modes;

receiving requests to establish communications sessions such that each session has quality of service requirements;

determining an acceptable session tariff for each of said sessions based upon comparing said quality of service requirements to said pre-established parameter values for said plurality of modes;

selecting among said modes on a session-by-session basis to determine which of said modes provides a highest present-time quality of service at a session tariff which is at or below said acceptable session tariff, said highest present-time quality of service being based upon said determined present-time parameter values for said plurality of modes; and utilizing said selected modes on a session-by-session basis to implement said sessions.

2. The method of claim 1 further comprising a step of executing in-session switching from said selected mode to an alternative mode in response to detecting that said alternative mode has a session tariff at or below said acceptable session tariff and a higher present-time quality of service than said selected mode.

3. The method of claim 2 wherein said step of executing in-session switching includes weighting said pre-established session tariff of said alternative mode in determining whether to switch to said alternative mode, said weighting being indicative of a connection cost for utilizing said alternative mode.

4. The method of claim 1 wherein said step of determining an acceptable session tariff includes determining which of said modes are acceptable with respect to satisfying said quality of service requirements for a particular session and further includes identifying which one of said acceptable modes has a lowest pre-established session tariff, said lowest pre-established session tariff thereby being designated the acceptable session tariff.

5. The method of claim 1 wherein said step of accessing capability to exchange communication data includes providing access to various modes for implementing real-time multimedia sessions.

6. The method of claim 5 wherein said step that includes providing access to said various modes includes providing a selection of modes that are distinguishable with respect to protocol, with one of said modes utilizing the Internet Protocol.

7. The method of claim 1 wherein said step of receiving requests is a step of receiving requests to establish a telecommunications session having specified quality of service parameter values.

8. The method of claim 1 wherein said steps of monitoring said modes and selecting among said modes are executed during said sessions to enable in-session switching between modes that each satisfy said quality of service requirements of said particular session.

9. The method of claim 8 further comprising a step of in-session switching from a particular mode when it is determined that said present-time parameter values of said particular mode no longer satisfy said quality of service requirements of said particular session.

10. The method of claim 8 further comprising a step of reserving communications resources of an unselected mode such that each session has reserved

communications resources for said in-session switching, said unselected mode for said particular session being that mode which satisfies requested quality of service requirements of said particular session at said acceptable session tariff for said particular session.

11. A method of managing transmissions between remote sites during a real-time multimedia session comprising steps of:

receiving requested quality of service requirements for said multimedia session;
selecting among a plurality of available communications modes for conducting said multimedia session, including selecting among modes that are distinguishable with respect to protocol, one of said protocols being an Internet Protocol, selection of a first mode being at least partially based upon differences in quality of service parameters for said modes;
continuously monitoring available present-time quality of service for each of said modes such that variations in quality of service for said modes are detected; and
switching from said first mode to a second mode upon detection that said second mode has a present-time quality of service satisfying said requirements of said multimedia session and that utilizing said second mode is more cost-efficient than said first mode utilized in conducting said multimedia session.

12. The method of claim 11 wherein said step of selecting among said modes further includes selecting from among modes distinguishable with respect to transmission media, including analog lines and digital lines.

13. The method of claim 11 further comprising a step of continuously reserving resources of one of said modes having pre-established quality of service parameters satisfying said requirements of said multimedia session, such that said reserved resources remain available to said multimedia session.

14. The method of claim 11 further comprising a step of switching from said second mode upon detection that either said second mode no longer satisfies said requirements or that a third mode satisfies said requirements and is more cost-efficient than said second mode.

15. The method of claim 11 wherein said step of selecting among said modes includes selecting said first mode based upon present-time qualities of service and upon session tariffs of said modes.

16. A method of managing communications routing comprising steps of:

accessing capability to exchange communication data between remotely located sites using any of a plurality of distinct communications modes having pre-established session tariffs; monitoring said modes to determine present-time quality of service parameter values for said modes; receiving a request to establish a communications session such that said request indicates a minimum quality of service and a maximum session tariff; if one of said modes satisfies said indicated minimum quality of service within said maximum session tariff, establishing connectivity for said session utilizing said one of said modes; and if none of said modes satisfies said indicated minimum quality of service within said maximum session tariff, then

- (a) queuing said request;
- (b) tracking said monitored present-time quality of service parameter values for said modes until a specific mode has a present-time quality of service that satisfies said indicated minimum quality of service within said maximum session tariff; and
- (c) selecting said specific mode for establishing connectivity for said session.

17. The method of claim 16 further comprising a step (d) of notifying a user of availability of said specific mode subsequent to said step (c) of selecting said specific mode and prior to establishing connectivity.

18. A system for managing real-time communications sessions comprising:

a plurality of types of interfaces to provide connections for conducting a communications session, different interfaces being compatible with different communications modes, each mode having a pre-established session tariff and pre-established quality of service parameter values; means for comparing quality of service requirements of said session with said pre-established parameter values of said modes to select a subset of modes suitable for supporting said session; means, responsive to said comparing means, for designating a threshold session tariff for conducting said session, said threshold session tariff being a lowest pre-established session tariff of said subset of modes;

means connected to said interfaces for continuously monitoring present-time quality of service available for each of said modes; and means for switching modes during support of said session in response to said monitoring means detecting a mode having increased present-time quality of service and a pre-established session tariff not exceeding said threshold session tariff.

19. The system of claim 18 wherein said interfaces include at least one analog interface and at least one digital interface.

20. The system of claim 18 wherein said interfaces support multimedia sessions and at least one interface supports communications using Internet Protocol.

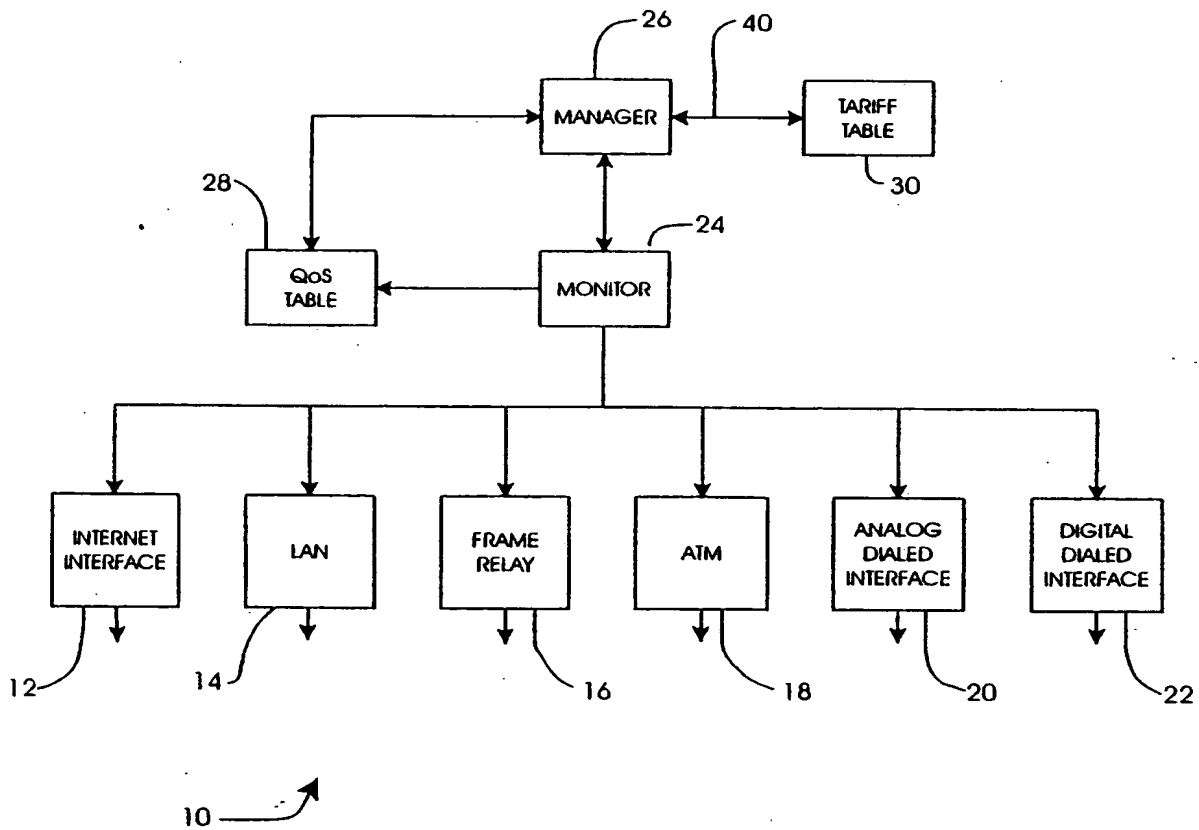


FIG. 1

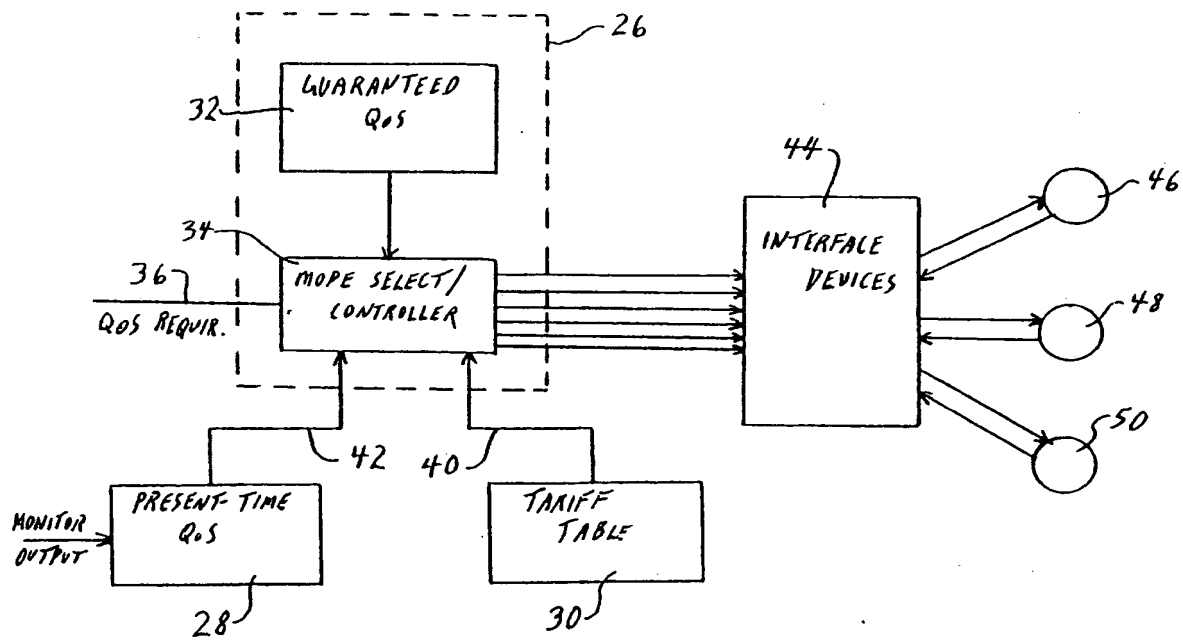


FIG. 2

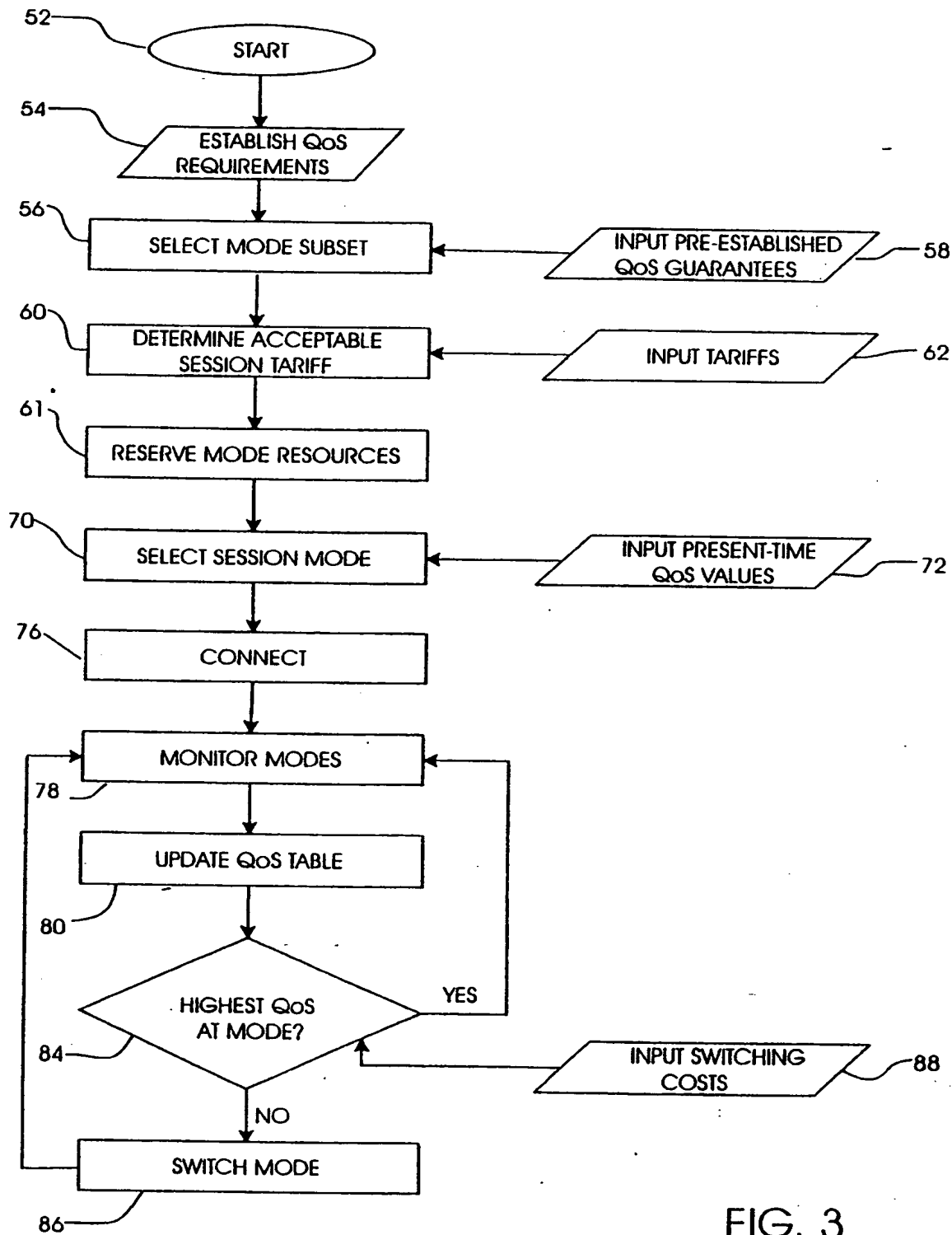


FIG. 3

MODE	SESSION TARIFF	GUARANTEED QoS	MONITORED QoS (t1)	MONITORED QoS (t2)
Internet	0	1	1	2
LAN	0	2	6	3
Frame Relay	1	4	7	4
ATM	2	6	6	9
Analog Dialed	3	9	9	9
Digital Dialed	4	10	10	10

FIG. 4

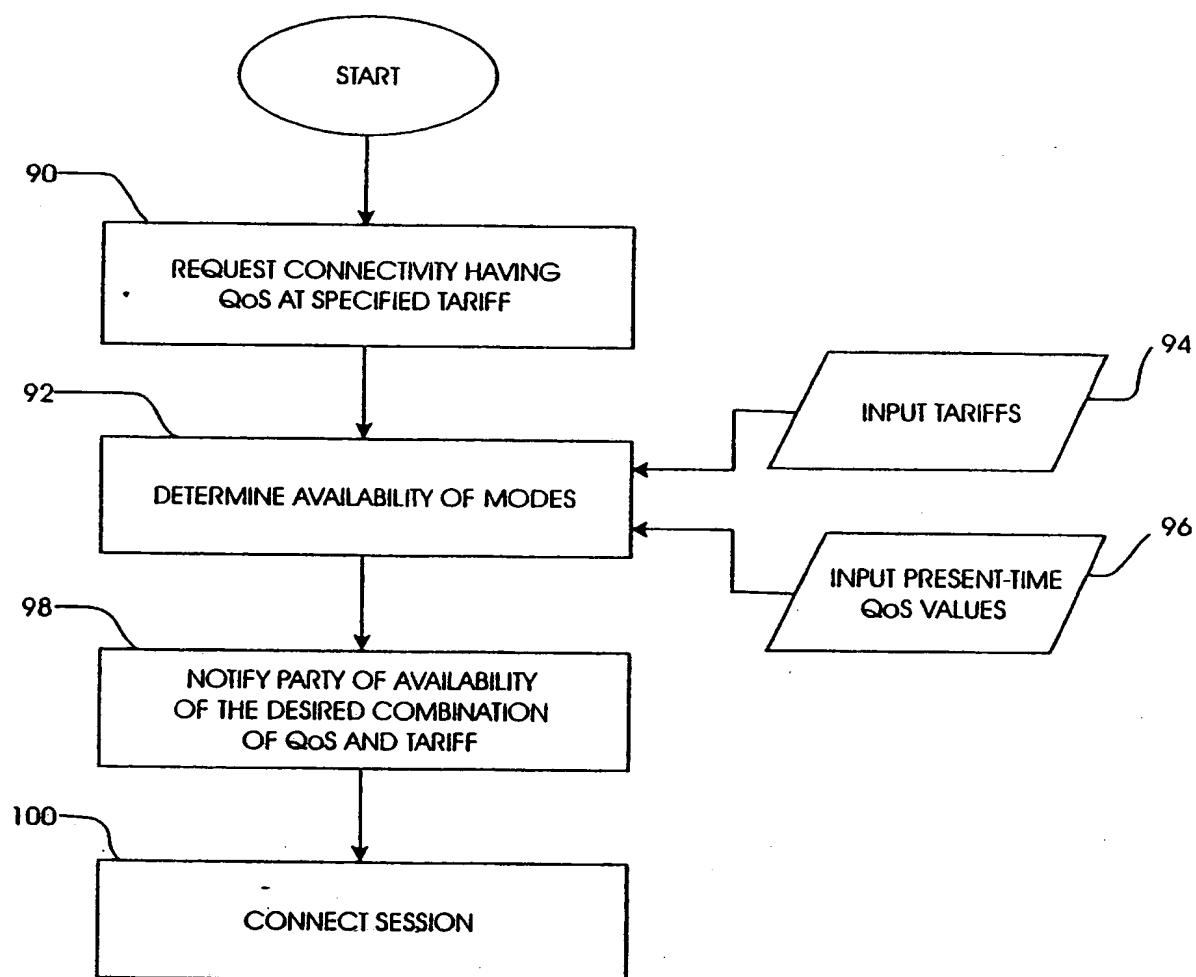


FIG. 5

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(54) Method and system for increasing quality of service at or below a threshold cost

(57) A method and system for managing the routing of communications data, such as real-time multimedia exchanges between remote sites, includes monitoring various communications modes, with each mode having pre-established quality of service parameter values and a pre-established session tariff. Some of the modes provide variable quality of service. The variable modes are monitored continuously to determine present-time quality of service parameter values. When a request to establish a communication session is received, the request will specify quality of service requirements. An acceptable session tariff is calculated based upon the match of the specified requirements with the pre-established parameter values of the modes. In a preferred embodiment, the next step is to select that mode having the highest quality of service available for a session tariff that does not exceed the predefined acceptable session tariff. In this embodiment, the tariff of the selected mode may be greater than an alternative mode that satisfies the QoS requirements, but only if the selected mode has a greater QoS. In another embodiment, real-time multimedia sessions are conducted using available modes that include the global Internet, and the session tariff becomes more of a factor. In a third embodiment, the user identifies a QoS level and an acceptable session tariff, and the system notifies the user when present-time quality of service is available at the acceptable session tariff.

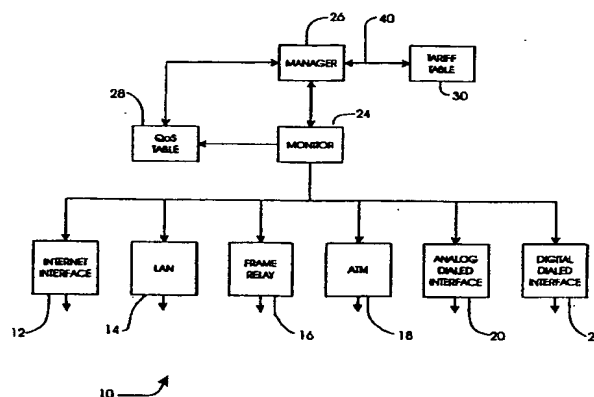


FIG. 1

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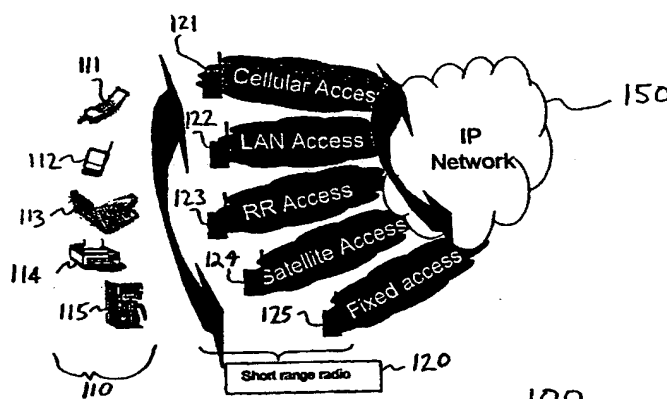
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(54) Title: METHOD AND APPARATUS FOR SELECTIVE NETWORK ACCESS



(57) Abstract: A method and apparatus for providing selective access to a network, between an end device and a network such as the Internet through one or more access network terminating devices includes determining an access capability for each access network terminating device and comparing the access capability with a preferred access capability associated with a user preference. Best access is determined based on a comparison of the capabilities of the access network terminating devices and the preferred capabilities. Once a match is found, one of the access network terminating devices is selected based on the comparison and the end device is configured according to the access capability of the selected one of the access network terminating devices. Access capabilities include, for example, cost of access, coverage area, and QoS. While communicating with the network the end device continues to detect if new access network terminating devices are available. The access capability for each of the new access network terminating devices is determined and compared with the preferred access capability and/or the current access capabilities being provided to the end device. One of the new access network terminating devices can be selected based on the comparison and the end device configured according to the access capability of the new access network terminating device.

METHOD AND APPARATUS FOR SELECTIVE NETWORK ACCESS

BACKGROUND

5 The present invention relates to telecommunications and data communications, and more particularly to a method and apparatus for providing end devices with network access (e.g., Internet access) by selecting from a plurality of network terminating devices and corresponding access networks.

10 For connecting an end device (e.g., a phone, computer, appliance, vending machine, car, etc.) to the Internet and associated networking environments in existence today, there is a wide choice of different access mechanisms including fixed access, cellular access, WLAN access, satellite access, and the like, which are available to provide access to the IP network. In order to use an access mechanism, a network terminating device is needed to connect the end device to the access
15 network and, through the access network, to the Internet. For example, a cable or wire pair are examples of a network terminating device associated with a fixed access network through which an end device can be connected to, e.g., the Internet. Likewise, a cellular phone is an example of a network terminating device associated with the cellular wireless access network, which provides another route for end
20 devices to be connected to the Internet. Yet another example is a PCMCIA card for WLAN network access which also may be used by an end device to communicate with the Internet. Those skilled in the art will recognize many other examples of network terminating devices and their corresponding access networks through which end devices may reach other networks.

25 For many end devices, it would be desirable to be able to use different access mechanisms (i.e., network terminating devices and access networks) for different connection situations, depending on factors including, for example, availability, pricing, bandwidth and the like. However, many end devices are configured to use only one type of access mechanism. For example, many personal computers can

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only connect to the Internet via a wireline modem and the fixed telephone access network.

In order to use different access mechanisms, an end device must have a network terminating device for each access network. Therefore, for end devices
5 such as a laptop computer, either several network terminating devices are required to be permanently installed in the laptop or network terminating devices have to be disconnected and reconnected to the laptop each time a different access mechanism is desired. A problem arises in that if network terminating devices must be disconnected and reconnected it is difficult to determine for any given point in time
10 which access mechanism provides the best quality connection to the ultimate network of interest, e.g., the Internet.

Providing such a determination was attempted in the BARWAN project at the University of California at Berkeley. In the BARWAN project, a laptop was equipped with access mechanisms including, for example, IR, WLAN (both of
15 which were used to access a LAN), Ricochet, CDPD and satellite interfaces. The access mechanism that could offer the best quality for the moment was used for data transfer. Since each of the access mechanisms provided different coverage, different access mechanisms were used depending on where the user was located, for example, at the office, in the car, and the like. Again, however, the difficulty with
20 such a system is that a separate network terminating device was provided directly to the end device for each access mechanism leading to the need for additional hardware and correspondingly higher costs. Moreover, given that space and power consumption, for example, are important considerations for end devices such as cellular phones and laptops, additional disadvantages may be posed by the additional
25 hardware required to provide a separate network terminating device for each access mechanism.

More flexibility and lower cost would be possible in such a system, particularly in a multi-user environment such as an office, where sharing of such

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network terminating devices is possible. Sharing may require, for example, a wireless interface between each of the end devices and the network terminating devices, so that the network terminating devices can be "shared" among many users. In this way a user can make use of whatever access network terminating device is available at a given point in time, without the need for a direct, physical connection to each network terminating device. Such an approach to sharing has been studied at the Internet Real-time Laboratory at Columbia University and was summarized in a paper entitled "Connection Sharing in an Ad Hoc Wireless Network Among Collaborating Hosts", by M. Papadopouli, and H. Schulzrinne, (http://www.cs.columbia.edu/~maria/nossdav99_final.ps).

In the Columbia project, a framework for collaborating among hosts to share a limited number of network connections with each other is being contemplated. The goal is to increase a quality metric and data availability primarily by performing load balancing between different network terminating devices which might be available depending on the demand from the users in the shared environment. Each access device measures the traffic that passes through it and provides that information to the end devices so that the end devices can choose the access device which is least loaded. Such a system however, may not achieve the "best" possible access for a given end device, since different types of end devices and connections may have widely varying connection considerations in determining what constitutes a "best" access. For certain types of connections, available bandwidth may be a primary "best" access consideration, while for other types of connections low delay time might be paramount.

Another drawback of the system evaluated in the Columbia project is its usage of collaborating hosts which provides a uniform, but rigid, access opportunity for end devices. Instead, it would be desirable to provide a more flexible system wherein different types of end devices may have different selection criteria with respect to different types of network terminating devices and access networks. For

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example, some network terminating devices may be provided which offer access to anyone (i.e., public access points placed in airports, shopping malls, etc.), some network terminating devices may be provided which offer access to a specified group of people (i.e., employees of a particular company or participants in a particular conference) and some network terminating devices may be provided which offer access only to a particular end device. In such an environment, it would be desirable to permit an end device, particularly a mobile end device, to employ more sophisticated access network selection techniques so that a user can have preferred network accesses given various access options which might be available (e.g., "I want to use my own access devices whenever possible, and the cheapest public access device in all other cases").

Yet another drawback of the Columbia system is that once an end device is linked to an external network through one of the collaborating hosts, it continues to operate through that host for the duration of the connection. Even if that particular host was a good choice initially, it may not always provide the best possible connection for the entire time that the link is operative.

It would be desirable, therefore, to develop a method and apparatus which provide selective and flexible connectivity to a plurality of network terminating devices to select an access mechanism which provides a best possible access for each situation. Such a method and apparatus should provide access to, e.g., the Internet, without the need for a plurality of network terminating devices to be physically integrated into the end devices, and in a user friendly manner.

SUMMARY

To provide a flexible and adjustably optimal connection to a network, e.g., the Internet, a method and apparatus for selective access to a plurality of different access networks by end devices is disclosed. It is therefore an object of the present invention to provide a method and apparatus capable of providing selective access

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for each access situation as determined by, among other things, user preferences related to factors such as cost of service, quality of service, etc. and the capabilities of access networks available to the end device.

5 In accordance with one aspect of the present invention, the foregoing and other objects are achieved in a method and apparatus for providing selective access to a network, for example by linking an end device to the network via an access network using a network terminating device. The end device may (or may not) have a direct interface usable for data and/or voice communications. The end device is equipped with an indirect interface and uses the indirect interface to determine the
10 access capability for each access network which is available to the end device. The access capabilities may include, for example, cost of access, coverage area, available bandwidth, delay and QoS. The determined access capability for each access network can be compared with a preferred access capability associated with the end device, or user thereof, wherein a particular access network can be selected based on,
15 for example, how favorably the determined access capabilities of each access network compare with the preferred capabilities of the end device or user. Accordingly the preferred capabilities may also include cost of access, coverage area, available bandwidth, delay and QoS and both the actual access network terminating device capabilities and the preferred capabilities may include other
20 factors such as the network type and the like. Based on the comparison, one of the access network terminating devices may be selected and the end device may be configured according to the access capabilities of the selected access network terminating device prior to connecting to the selected access network.

25 In accordance with a further embodiment of the present invention, the indirect interface may be also be used during the connection between the end device and the ultimate network to detect if new access network terminating devices are available to the end device. If new devices are detected, an access capability associated with each of the new access network terminating devices may be

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determined and a comparison may be made between the determined access capability associated with each new access network terminating device, the capabilities associated with the currently used access network terminating device and a preferred access capability associated with the end device. As in the previous
5 embodiment, a decision to reselect among the available access network terminating devices is based on the comparison. If a better access for the end device is identified, the new access network terminating device is selected and the end device may be reconfigured according to the access capability associated with the selected new access network terminating device.

10

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of the invention will be understood by reading the following detailed description in conjunction with the drawings, in which:

FIG. 1 is a diagram illustrating an exemplary access network environment;

15

FIG. 2 is a block diagram illustrating an exemplary indirect interface between an end device and an access network terminating device in accordance with an exemplary embodiment of the present invention;

FIG. 3 is a hardware block diagram illustrating an exemplary end device and an exemplary access network terminating device in accordance with the present
20 invention; and

FIG. 4 is a flowchart illustrating exemplary steps including device discovery, access discovery, access selection, and access configuration in accordance with the present invention.

25

DETAILED DESCRIPTION

The various features of the invention will now be described with reference to the figures, in which like parts are identified with the same reference characters. In the following description, for purposes of explanation and not limitation, specific

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details are set forth, such as particular circuits, circuit components, techniques, etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances,
5 detailed descriptions of well-known methods, devices, and circuits are omitted so as not to obscure the description of the present invention.

In accordance with an exemplary embodiment of the present invention it is desired therefore, to combine a plurality of access mechanisms, fixed as well as mobile, to flexibly select a "best" possible access for each situation. This should be
10 done without the need for a plurality of access network terminating devices being integrated into the end device, and in an easy way for the user.

FIG. 1 illustrates an exemplary system in which various end devices 110 are shown connected to an IP network 150, which IP network is for example the Internet or an Intranet. End devices 110 can come in many forms, for example, cellular
15 phone 111, wireless palmtop computer 112, laptop 113, printer 114, and even intelligent household devices such as coffee pot 115. Those skilled in the art will appreciate that these are just a few examples of end devices which can be used in conjunction with the present invention. Access to IP network 150 can be made through an indirect interface 120, e.g., a short range radio interface such as that
20 provided by Bluetooth technology. The interface 120 between the end devices 110 and the plurality of access network terminating devices 121-125 is referred to herein as an "indirect" interface because some of the end devices 110 may also have a direct interface for communicating with their traditional networks. For example, cellular phone 111 may have, as its direct interface, a GSM cellular interface. On the
25 other hand some end devices 110, e.g., those which do not otherwise have a communication function such as coffee pot 115, may not have a direct interface.

Indirect interface 120 may be configured to interface with terminating devices 121-125 for any one of a number of exemplary network access mechanisms

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such as, for example, cellular access mechanism 121, LAN access mechanism 122, Ricochet access mechanism 123, satellite access mechanism 124, and fixed access mechanism 125. It is important to note that while specific access mechanisms may be described herein for exemplary purposes, it is contemplated that new access mechanisms or access mechanisms not specifically enumerated are within the scope of the present invention.

As was described above, indirect interface 120 may be embodied, for example, as a short range wireless transmission system. One example of such an interface is that defined by the recently developed "Bluetooth" technology which facilitates two-way data transmission. Bluetooth is a universal radio interface in the 2.45 GHz frequency band that enables portable electronic devices to connect and communicate wirelessly via short-range, ad hoc networks. Readers interested in various details regarding the Bluetooth technology are referred to the article entitled "BLUETOOTH -- The universal radio interface for ad hoc, wireless connectivity" authored by Jaap Haartsen and found in the Ericsson Review, Telecommunications Technology Journal No. 3, 1998, the disclosure of which is incorporated here by reference. For the purposes of the present invention, only Bluetooth features of immediate interest are described here to avoid obscuring these exemplary embodiments. Moreover, the indirect interface 120 can be embodied using interfaces other than Bluetooth interfaces.

In this application of a Bluetooth system as an indirect interface for end devices, a Bluetooth transceiver (illustrated in FIG. 3) is associated with, for example, each of the plurality of network terminating devices 121-125. The transceiver may act as a master device and continuously transmit, for example, INQUIRE messages for receipt by any end device 110 that may be in the vicinity. Another Bluetooth transceiver, included in each end device 110, would respond to this transmitted message. End device 110 may then proceed through indirect interface 120 to lock on to a channel of the indirect interface 120.

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Alternatively, the master/slave roles may be reversed and the Bluetooth transceiver of an end device 110 may send the INQUIRE messages to seek network terminating devices. Then, Bluetooth transceivers of network terminating devices within range of the end device 110 will respond to establish a Bluetooth link therewith in order to exchange capability information as described below. In this way, end devices 110 need only a single e.g., Bluetooth, indirect interface 120 to select any one of the plurality of access network terminating devices that are available within reach of indirect interface 120. If end device 110 knows what kind of access network terminating devices are available, it may compare factors such as cost, quality, and the like, associated with each available access network and choose the "best" one according to a selection scheme, as described in more detail below. The current values for these (and other) factors can be transmitted over the indirect interface 120 to the end device 110 for evaluation and selection.

To better understand the configuration of the fixed and mobile or remote portions of indirect interface 120, reference is now made to FIG. 2 wherein a diagram illustrating an exemplary indirect interface between end device 210 and network terminating device 220 is shown. User preferences 211 may be kept in end device 210, e.g., stored in a local memory and updated by a user, and may be related to those factors (e.g. cost, QoS, and the like) considered by the user to be of greatest importance in selecting which access mechanism to use for communicating data with network 150. Prior to comparing user preferences 211 with corresponding capabilities of access networks, it is first determined which access mechanism(s) are available. Access discovery protocol blocks 214 and 224 perform the polling over the indirect interface 120 described above (in either direction) to identify the available access mechanisms for a particular end device 110. Thus, access discovery protocol blocks 214 and 224 also perform the initial "handshaking" needed to establish a communication link 230 between the end device 210 and the access

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network terminating device 220, e.g., by allocating a Bluetooth channel there between.

Current information about the network access available via network terminating device 220 may be kept in information block 221, which may be stored
5 in a local memory, continuously updated, or the like. As part of the access discovery protocols performed by blocks 214 and 224, this information may be transferred to the end device 210 over link 230.

Information so obtained by end device 210 may be used for subsequent comparison to user preferences 211 in access selection step 212. When a suitable
10 match is found between user preferences 211 and access information received from information block 221 related to the access characteristics of access network terminating device 220, that terminating device (and its corresponding access network) is selected. Then, configuration may begin with configuration block 213 establishing configuration information exchange 240 with corresponding
15 configuration process 223 of access network terminating device 220.

This configuration information is used to ensure that data packets to be transmitted between end device 210 and the IP network 150 are routed correctly. For example, this configuration information can include an IP address associated with the selected access network, as well as other information, e.g., subnet, gateway,
20 DNS server information, etc. The end device 210 can receive an IP address that is valid in the selected access network, in which case the end device 210 has a direct connection to the IP network 150 and can transmit and receive data packets directly therewith.

Alternatively, the end device 210 and the network terminating device 220
25 can agree on a dummy IP address associated with their connection (i.e., an IP address that is not valid in the access network) and the connection to the IP network 150 can be made using an IP address assigned to the network terminating device 220. Those skilled in the art will appreciate that there are many techniques available

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for configuring end device 210 and network terminating device 220 so as to provide an IP connection, any of which may be employed herein. However, the interested reader is directed to "The IP Network Address Translator (NAT)", IETF RFC 1631, to K. Egevang and P. Francis, May 1994, <ftp://ftp.isi.edu/in-notes/rfc1631.txt>, the disclosure of which is incorporated here by reference.

Alternatively, or additionally, if the network terminating device 220 and/or its corresponding access network support Mobile IP (see, for example, "IP Mobility Support" IETF RFC 2002, to C. Perkins, October 1996, <ftp://ftp.isi.edu/in-notes/rfc2002.txt>, the disclosure of which is also incorporated here by reference), the end device 210 offers a so-called foreign agent to the network terminating device 220 as part of the configuration process. Using Mobile IP in this way is particularly advantageous in the context of the present invention since Mobile IP supports handover between foreign agents which means that ongoing TCP connections will not be broken if the end device 210 selects another network terminating device 220 during the connection.

Once end device 210 is properly configured, access may be attempted and granted from access network terminating device 220 by an appropriate exchange with access control block 222, which may require authorization and related registration procedures as are known in the art for gaining access to network 150.

It should be noted that in, general, three steps are performed to establish a network connection between end device 210 and, for example, network 150 as shown in FIG. 1. First, end device 210 discovers which of the plurality of access network terminating devices are available, then the "best" access mechanism to use for the present moment is selected based on the type of access network terminating devices found and the user's preferences, and finally configuration for the chosen access network is performed.

An exemplary hardware block diagram is illustrated in FIG. 3 in accordance with an exemplary embodiment of the present invention. End device 310, which

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may correspond to any of the devices illustrated in FIG. 1 (or some other device) that has both a direct and indirect transceiver, and in the exemplary embodiment shown in FIG. 3, may be, for example, a cellular phone. End device 310 may be equipped with direct transceiver 340, and antenna 341 for conducting normal data transfer using, e.g., a cellular interface having traffic and control channels in accordance with known air interface standards and cellular telephone practices.

Indirect transceiver 330 with antenna 331 may form a portion of indirect interface 300 and is preferably the only interface required to connect with the network terminating devices which can be used to connect end device 310 with IP network 380. Processor 320 may be configured to conduct steps such as, for example, device discovery, access discovery, access selection and the collection of user preferences. User preferences may be obtained in a number of ways e.g., via voice or key input, as would be apparent to one skilled in the art and may further be stored in memory 321.

In network terminating device 350, which includes, for example, a fixed portion of indirect interface 300 and can be located in a mall, there will be another indirect transceiver 360 for communicating with the indirect transceiver 330 in the end device 310. The transceiver 360 may be configured to communicate via antenna 361 over an air interface to indirect transceiver 330 in end device 310 to establish device discovery, access discovery, and configuration as previously described with reference to FIG. 2. Processor 370 of device 350 communicates with access mechanisms 354, which represents the various structure and/or circuitry need to interface with the access network 375. For example, if the access network 375 is a wireline, telephone network (PSTN), then the access mechanism 354 can be implemented as a telephone modem. Information regarding potential access to IP network 380 via access network 375 (e.g., current available bandwidth, average BER, subscription class for which access network 375 is currently accepting connections, etc) may be obtained by processor 370 continuously or periodically via

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access mechanism 354 and stored in memory 371. Although only one network terminating device 350 is illustrated in FIG. 3 to simplify the figure, it will be appreciated that, in practice, end device 310 is expected to be within range of more than one network terminating device 350 at some times.

5 To better understand an exemplary process by which selective access may be practiced, FIG. 4 may be referred to which illustrates an exemplary flowchart in accordance with the present invention. When an end device, such as exemplary end device 310, or any end device as illustrated in FIG. 1- FIG. 3 wants access to, for example, an IP network, it has to first find out if such access is possible based on
10 whether there are any access network terminating devices available, such as, for example, access network terminating device 354. From start block 410, decision block 411 may represent such a process by which an end device determines whether there are any access network terminating devices present. As mentioned earlier, this may include actively polling network terminating devices by transmitting a request
15 and/or listening for announcements that are periodically transmitted by the network terminating devices. If no network terminating devices are located, then block 412 represents a network terminating device discovery process which loops back to continue to poll or listen for network terminating devices.

 If one or more network terminating devices are detected, then the end device
20 may determine the identity of the access mechanism and associated access capabilities of the access network terminating devices as represented in block 413, based on information, such as that provided, for example, in information exchange 230 described with reference to FIG. 2. In order to ultimately select which access network terminating device(s) to use if there are several available, or to determine
25 whether to use an access network terminating device or not if there is only one, the end device obtains information about the access network terminating device, its associated access network and their cumulative or respective access capabilities. Such information may include, for example, the cost of access, bandwidth available,

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QoS parameters, priority level available, delay and the like as illustrated in block 414. Thus, the phrase "access capabilities" as it is used herein refers to one or more of these (and other factors) associated with the access network terminating device, its corresponding access network, both the access network terminating device and its
5 corresponding access network, or any other network components which may impact the parameter(s) of interest to the end device with respect to a potential connection with the ultimate network.

If the network terminating devices are broadcasting announcements that indicate their presence to end devices, then these announcements may include access
10 capability information associated therewith. The announcement may include information regarding all of the access parameters of interest, or may include information regarding only a subset of the access parameters which are more commonly included in the user preferences stored in memory 321. If the announcement does not include sufficient information for the end device to make a
15 selection based upon the selection function performed by processor 320, then the end device sends another request to the network terminating device as part of step 412.

If the kind of access mechanism provided and associated access capabilities favorably compare to that established by, for example, user preferences 211, which
20 comparison is represented in block 415, then a second comparison may be made in block 417 to determine if the present match is the best match of all available access network terminating devices. If the access mechanism does not favorably compare, then as represented by block 416, the next device, if any, is checked. In any case, all available access network terminating devices are checked until the one with the most
25 favorable comparison to user preferences 211 is found. It should be noted that the basis for comparison may be established such that even in the event that none of the available access network terminating devices exactly meets the criteria established by user preferences 211, that some selection may be made, or in the alternative one

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of the user preferences may specify that an exact match must be made. Accordingly, the choice of how to select from available access network terminating devices will be made based on individual preferences. For example, "best" access may, for one user, be the cheapest access mechanism, or, for a different user, it might be the fastest access mechanism.

As is represented in block 419, a configuration step may be performed once a "best access" match is found in accordance with the above described procedure and the description of configuration information exchange 240 described above with reference to FIG. 2. After configuration step 419 is complete, access may be completed and communication with network 150 may begin. It should be noted that in order to ensure that the "best" access is provided continuously or nearly continuously, a periodic search may be made for available access network terminating devices as represented by step 420. Even after the end device has chosen one network terminating device to use, it can continue to look for other available network terminating devices. If a new network terminating device is a better "best access" match than the one currently used, as represented by decision block 422, the end device may reconfigure and change to the new access network terminating device as represented by block 421. A hysteresis value can be used to avoid "ping-ponging" between network terminating devices which have similar match values with respect to a particular end device's selection algorithm.

If there are more devices to check, all devices should be checked first in the event there is a better match than the present new network terminating device as represented in block 423. If no more network terminating devices are present and the present new network terminating device is not a better "best access" match, the process may be returned to block 420 to continuously look for new devices. It is to be noted that in accordance with an exemplary embodiment of the present invention, the selection of an access network terminating device should be an automatic process. Likewise, the necessary configuration needed to use the specific access

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should also be done automatically in a manner as would be known to one skilled in the art.

The invention has been described with reference to a particular embodiment. However, it will be readily apparent to those skilled in the art that it is possible to
5 embody the invention in specific forms other than those of the preferred embodiment described above. For example, although network access has been described in these exemplary embodiments as providing a direct path from an end device through a network terminating device and access network to an ultimate (IP) network of interest, those skilled in the art will appreciate that intermediary nodes or networks
10 may be present.

Moreover, end devices having both a direct and indirect interface may operate as both an end device and a network terminating device. Consider that, once such an end device becomes connected to the IP network it is, itself, a termination of the linked networks. Since this connected end device is communicating with the IP
15 network using its indirect interface, it may act as a network terminating device if its primary interface is not being used for some other purpose. Consider the foregoing example wherein the end device is a cellular phone having, as its indirect interface, a Bluetooth transceiver. If the user of the cellular phone is browsing the worldwide web using its Bluetooth transceiver, its direct (cellular) transceiver may be idle and,
20 therefore, available for some other end device to connect with to reach the Internet. Thus, the cellular phone would also have a set of access capabilities which would reflect its ability to act as a conduit for the second end device.

Thus, it can be seen that these exemplary embodiments are merely illustrative and should not be considered restrictive in any way. The scope of the
25 invention is given by the appended claims, rather than the preceding description, and all variations and equivalents which fall within the range of the claims are intended to be embraced therein.

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WHAT IS CLAIMED IS:

1. A method of selectively accessing a network, using an end device having an indirect interface that can communicate with one or more access network terminating devices, the method comprising the steps of:

determining an access capability for each of the one or more access network terminating devices; and

comparing the determined access capability for the each of the one or more access network terminating devices with a preferred access capability associated with the end device, wherein at least one of the access network terminating devices is selected based on the comparison.

2. The method of claim 1, further comprising the step of:

configuring the end device according to the access capability of the selected at least one of the one or more access network terminating devices.

3. The method of claim 1, wherein the access capability further includes one or more of: cost of access, coverage area, bandwidth, delay, priority level and QoS.

4. The method of claim 1, wherein the preferred access capability further includes one or more of: cost of access, coverage area, bandwidth, delay, priority level and QoS.

5. The method of claim 1, further comprising the steps of:
polling the indirect interface to detect if one or more new access network terminating devices are available to the end device;

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determining an access capability for each of the one or more new access network terminating devices if detected; and

comparing the determined access capability for the each of the one or more detected new access network terminating devices with at least one of said preferred access capability associated with the end device and said access capability of a currently used access network terminating device, wherein one of said new access network terminating devices can be selected based on the comparison.

6. The method of claim 5, further comprising the steps of:

selecting one of the one or more new access network terminating devices based on the comparison; and

configuring the end device according the access capability of the selected one of the one or more new access network terminating devices.

7. A system for providing selective access to a network comprising:
an end device;

at least one access network terminating device for connecting said end device to said network; and

an indirect interface coupled to the end device and to said at least one access network terminating device, the indirect interface configured to:

determine an access capability for each of the at least one access network terminating device; and

compare the determined access capability for the each of the at least one access network terminating device with a preferred access capability associated with the end device, wherein one of said at least one access network terminating devices is selected based on the comparison.

8. The system of claim 7, further comprising:

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means for configuring the end device according the access capability of the selected one of the at least one access network terminating device.

9. The system of claim 7, wherein the access capability further includes
5 one or more of: cost of access, coverage area, and QoS.

10. The system of claim 7, wherein the preferred access capability further includes one or more of: cost of access, coverage area, and QoS.

10 11. The system of claim 8, further comprising:
means for polling to detect if one or more new access network terminating devices are available to the end device;
means for determining an access capability for each of the one or more new access network terminating devices if detected; and
15 means for comparing the determined access capability for the each of the one or more detected new access network terminating devices with at least one of said preferred access capability associated with the end device and an access capability of a currently employed access network terminating device, wherein one of said new access network terminating devices can be selected based on the
20 comparison.

12. The system of claim 11, further comprising:
means for configuring the end device according to the access capability of the selected one of the one or more new access network terminating devices.

25

13. The system of claim 8, wherein said end device is a cellular telephone.

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14. The system of claim 13, wherein said cellular telephone includes, as a direct interface, means for communicating over a cellular air interface and includes, as said indirect interface, means for communicating over a Bluetooth air interface.

5 15. An end device comprising:
 means for storing access network preferences;
 means for communicating with a plurality of network access
terminating devices over a indirect interface;
 means for selecting one of said plurality of network access
10 terminating devices by receiving access network capabilities associated with each of
said plurality of network access terminating devices over said indirect interface and
comparing said received access network capabilities with said stored access network
preferences.

15 16. The end device of claim 15, wherein said indirect interface is a
Bluetooth interface.

 17. The end device of claim 15, wherein said access network terminating
devices provide a communication link with the Internet.

20

 18. The end device of claim 15, further comprising:
 mean for communicating over a direct interface.

 19. The end device of claim 18, wherein said end device can
25 communicate simultaneously over said direct interface and said indirect interface.

 20. The end device of claim 18, wherein said direct interface is a cellular
interface.

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21. A method for selectively connecting an end device to a network comprising the steps of:

identifying at least one network terminating device available to said end device for connection to said network;

5 transferring capability information between said at least one network and said end device;

comparing said transferred capability information with stored user preferred capability information;

10 selecting one of said at least one network terminating device based on a result of said comparing step; and

connecting to said network using said selected network terminating device.

22. The method of claim 21, further comprising the step of:

15 continuing, after said connecting step, to identify network terminating devices available to said end device.

23. The method of claim 22, further comprising the step of:

20 determining if capability information associated with a newly identified network terminating device provides a greater match with said stored user preferred capability information than said selected network terminating device.

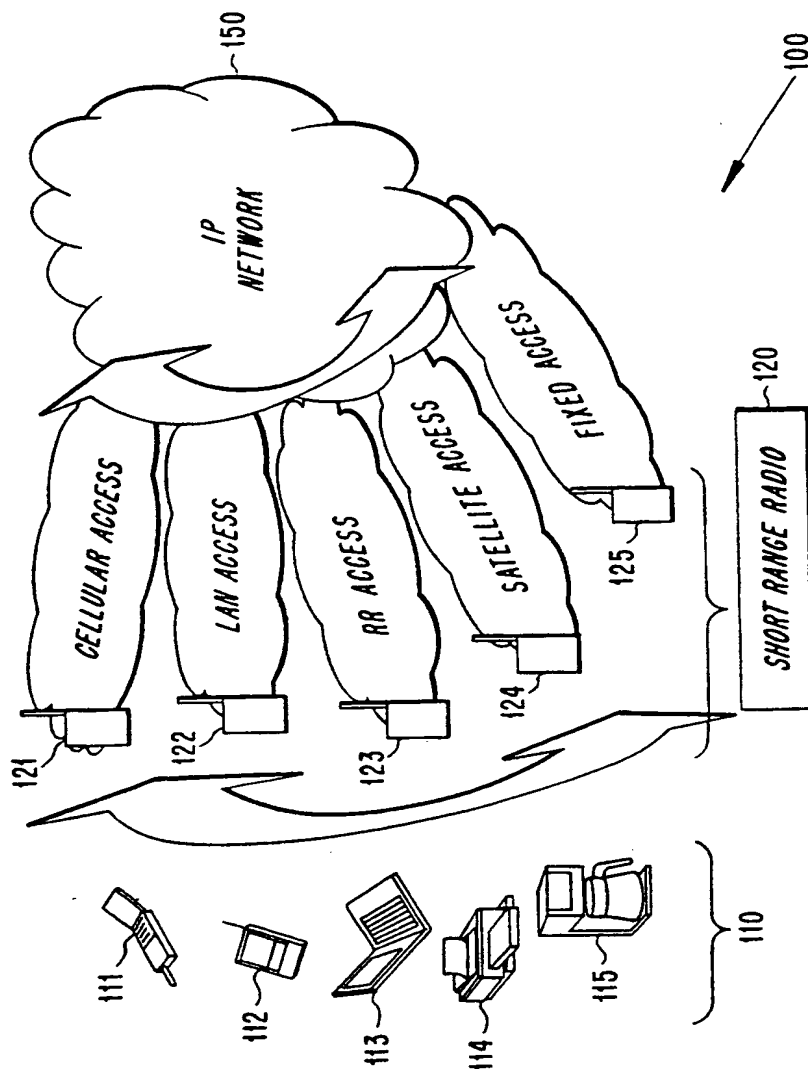
24. The method of claim 23 further comprising the step of:

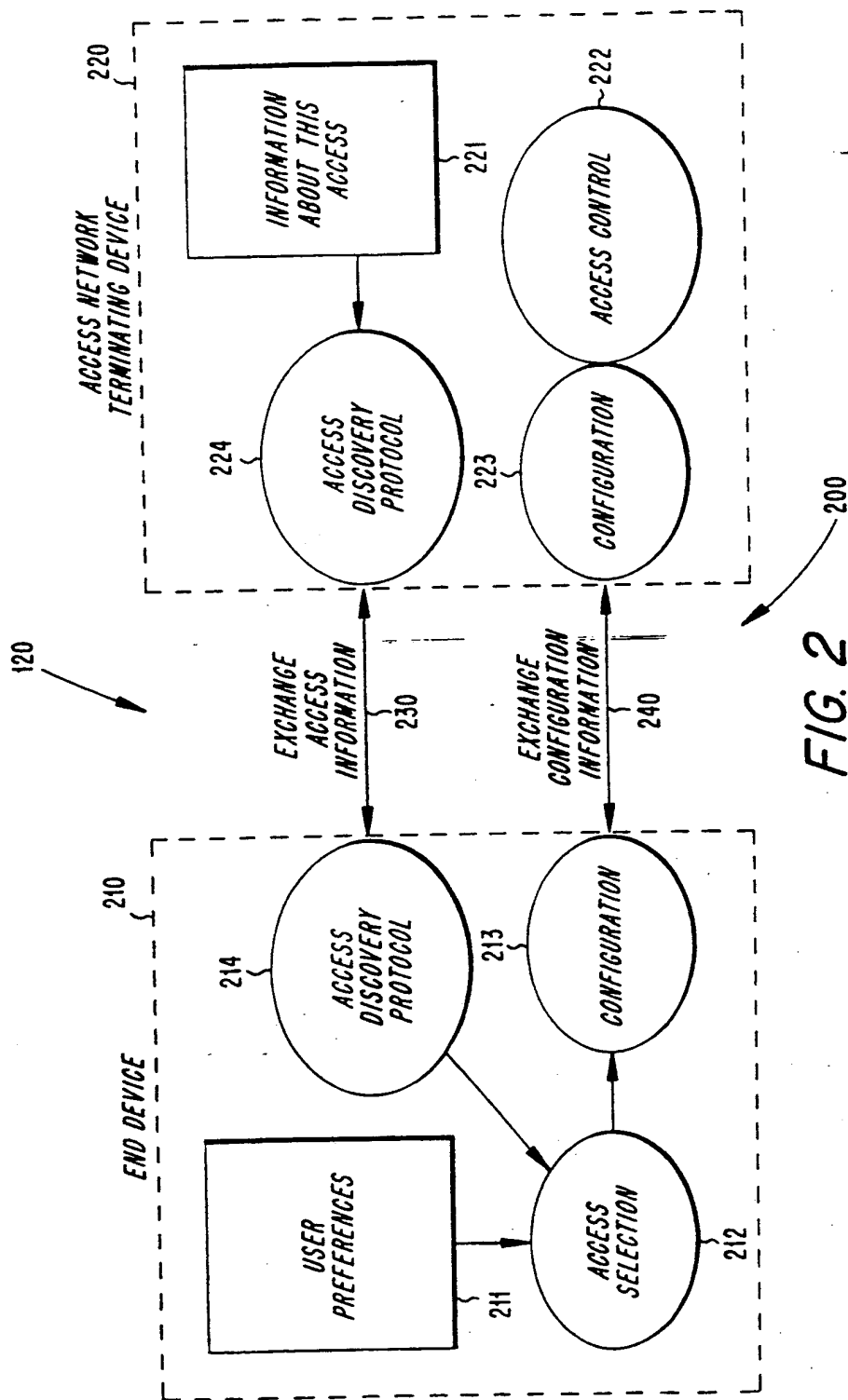
25 selectively changing said connection to said network from said selected network terminating device to said newly identified network terminating device based on a result of said determining step.

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25. The method of claim 21, wherein said step of transferring further comprises the step of:
- offering, from said at least one network terminating device, a foreign agent to said end device.

FIG. 1





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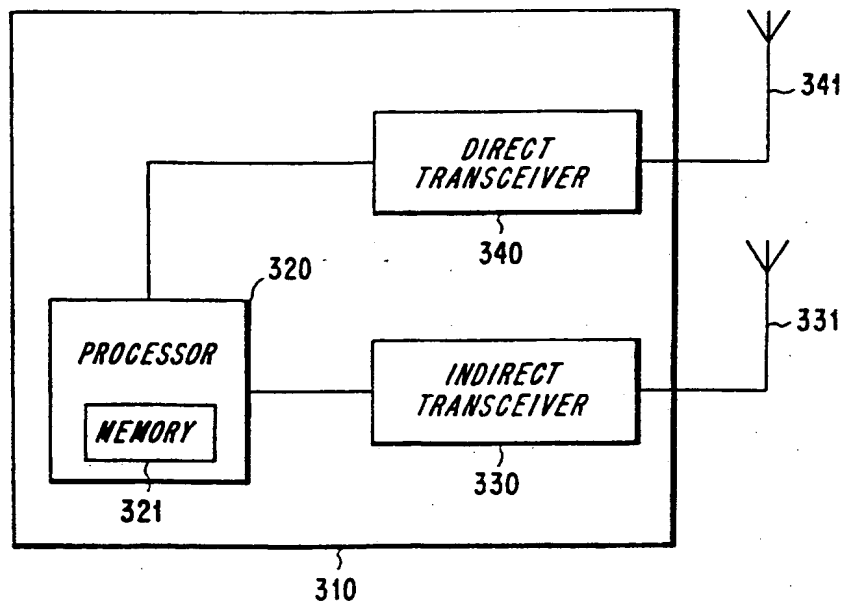
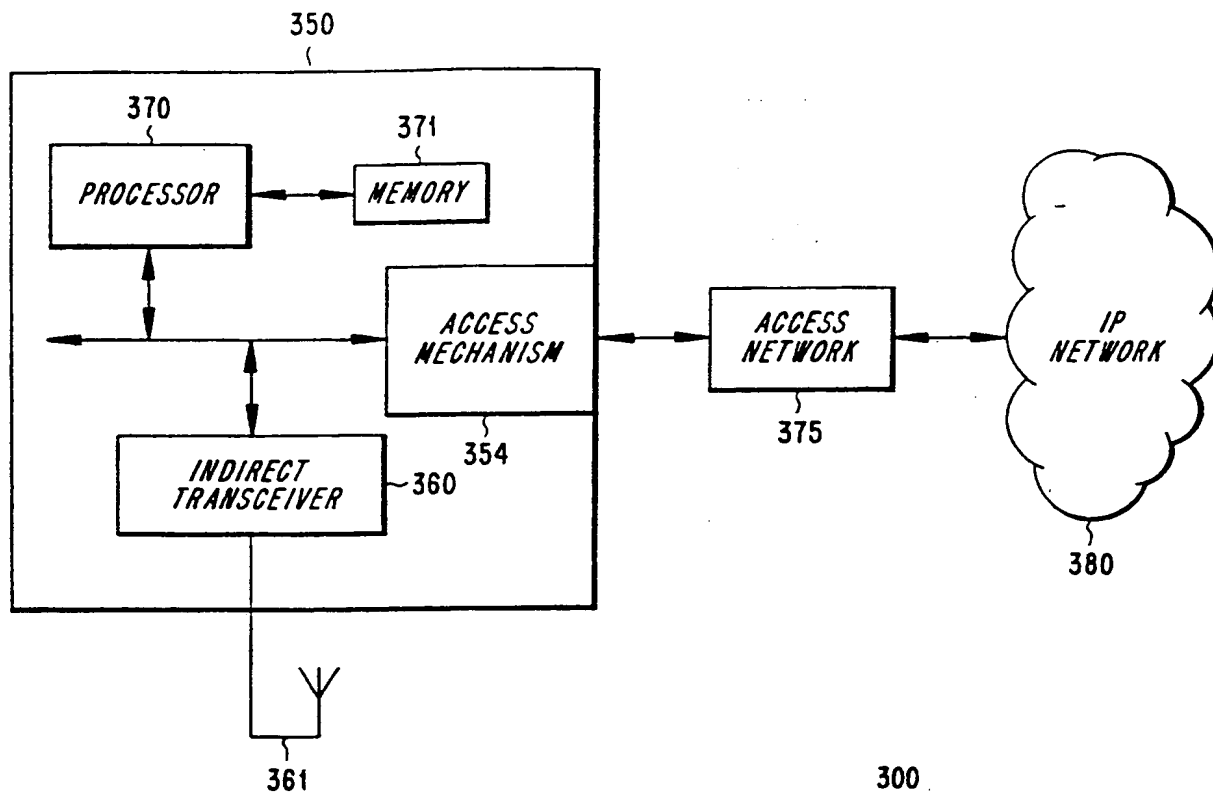
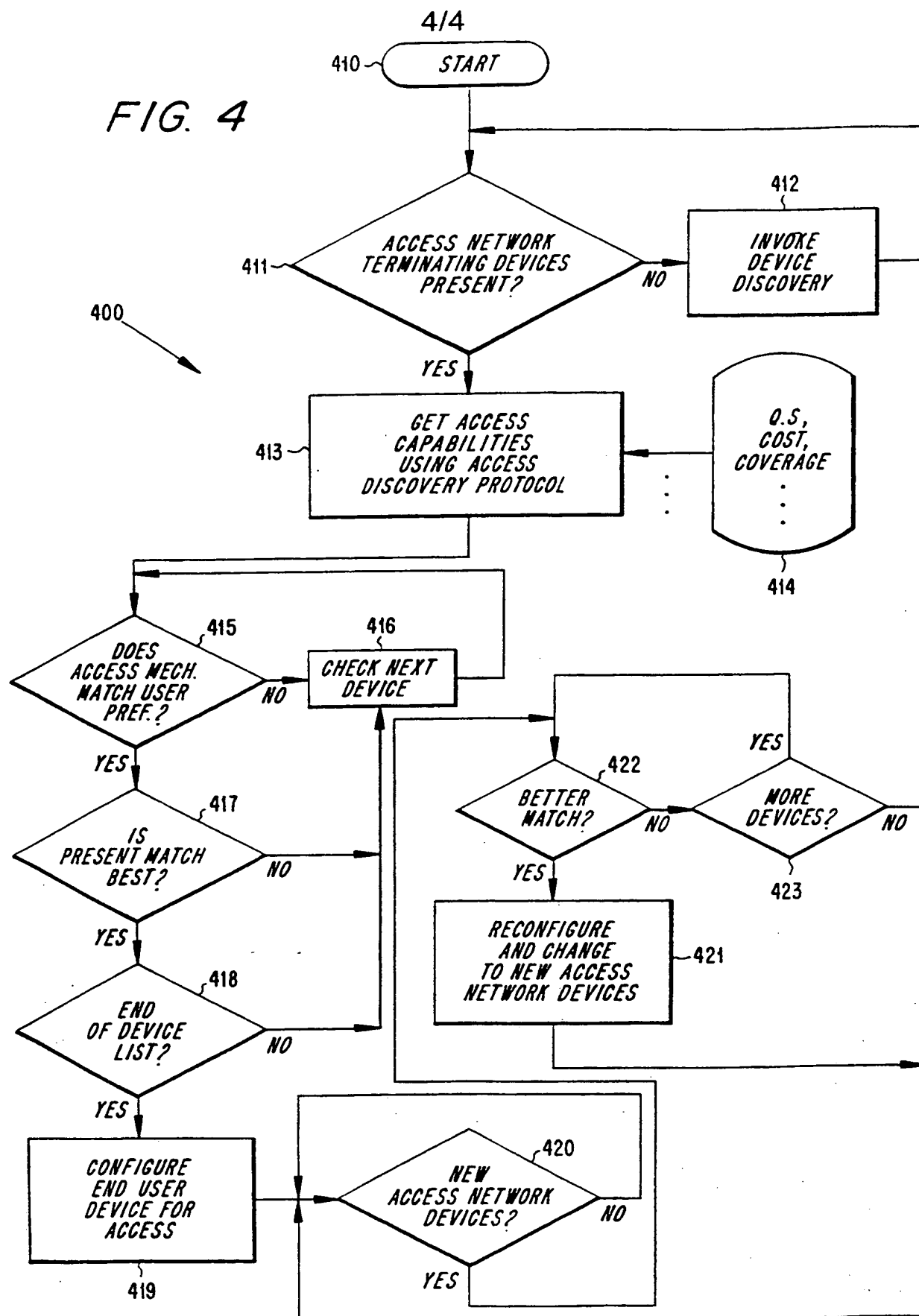


FIG. 3

FIG. 4



INTERNATIONAL SEARCH REPORT

Intern nal Application No

PCT/SE 00/02110

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04L12/56 H04L29/06 H04L12/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>WO 97 40638 A (LIND PATRIC ; TELIA AB PUBL (SE)) 30 October 1997 (1997-10-30) abstract page 1, line 31 -page 2, line 14 page 3, line 28 -page 4, line 8 page 4, line 32 -page 6, line 10 page 8, line 13 - line 32</p> <p style="text-align: center;">--- -/--</p>	1, 7, 15, 21

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

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O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

12 January 2001

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INTERNATIONAL SEARCH REPORT

Internal Application No

PCT/SE 00/02110

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>ALBRECHT M ET AL: "IP Services over Bluetooth: leading the way to a new mobility"</p> <p>PROCEEDINGS OF THE CONFERENCE ON LOCAL COMPUTER NETWORKS, October 1999 (1999-10), pages 2-11, XP002130784</p> <p>page 2, left-hand column, line 26 -right-hand column, line 33 page 4, left-hand column, line 8 - line 31 page 4, right-hand column, line 47 -page 5, right-hand column, line 10 page 6, right-hand column, line 17 - line 44 page 7, right-hand column, line 14 -page 8, left-hand column, line 11</p> <p>----</p>	1,7,15, 21
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